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INTELLIGENCE AND THE LANGUAGE-BOUND EFFECT

RUTH S. DAY

YALE UNIVERSITY

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Abstract

Individual differences in dichotic fusion experiments could be based on a number of different principles. The current working hypothesis suggests that the phenomenon reflects a language-binding effect; language-bound (LB) individuals perceive and remember events in language terms while language-optional (LO) individuals can use language structures or set them aside depending on task demands. The present paper explored an alternative interpretation, that the two types of individuals differ in overall intelligence levels. Three samples of subjects classified as LB or LO were studied, with about 50 subjects in each. There were no statistically reliable differences in overall scores between LBs and LOs for either the Scholastic Aptitude Test or a standard intelligence test. Thus it appears that the LB-LO distinction is not based on differences in overall intellectual ability. However other aspects of the data suggested that the two groups may achieve intelligent behavior in different ways.

Intelligence and the Language-Bound Effect

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Mind is a mass of tangled processes. Our problem is to dissect this complex, and to discover if we can, its plan and arrangement.

---Titchener

For a long time, psychologists have suspected that the mind is ordered according to some plan or arrangement. But how many plans, how many arrangements? Some have searched for the one plan that would reflect the basic workings of all normal humans, with only minor, inconsequential differences among individuals. Others have tried to devise ways to characterize all minds, each with its own set of plans and arrangements. Thus there has been a wide range of views, from one mind to an almost infinite number of minds.

It is possible that these two views represent extremes of a continuum, rather than the two bins of a dichotomy. Thus there could be some middle ground, where there are a few general plans according to which cognitive processes are patterned. For example, individuals could differ in the ways in which language structures influence their cognition. Results from auditory perception experiments (Day, 1969) suggest that some individuals may well be language-bound (LB) while others are language-optional (LO). These two groups of individuals show striking differences in a wide variety of cognitive tasks (see Day, 1977, for a brief overview), including remembering brief informati[illegible] (Day, 1973a), learning "secret languages" (Day, 1973b), and solving word-sear[illegible]es (Day, 1974).

It has been argued (Day, 1978) that LBs and LOs differ in qualitative ways, as if their minds were organized in different ways. Thus LBs might perceive and remember events in language terms, while LOs use language or set it aside, depending on the type of task at hand. In order to make such an argument convincing, it is necessary to determine whether the two groups differ more simply on quantitative grounds, that is, in terms of sheer overall intelligence. A brief

overview of the experiment used to classify individuals as LB or LO is useful in making a prediction concerning which group might be more intelligent.

The basic classification experiment involves dichotic items such as BANKET/LANKET which can be fused into sequences such as BLANKET but not LBANKET. When asked to report the first sound they heard in a temporal order judgment (TOJ) task, LBs report hearing the stop consonant (e.g., /b/) first even when the liquid (e.g., /l/) led by a considerable interval. LBs obey the phoneme sequence rules of English even when they are violated by the stimulus events. In contrast, LOs are highly accurate in judging temporal order no matter which phoneme led. While the differences between the two groups in this experiment could be based on different overall arrangements of cognitive processes, it could be instead that LOs achieve more accurate performance simply because they are more intelligent.

The present inquiry was designed to determine whether in fact LBs and LOs differ in intelligence. It was intended to be a preliminary study aimed at detecting gross differences in intellectual ability.

Scholastic Aptitude Test

The Scholastic Aptitude Test (SAT) is widely used to assess the general intellectual capabilities of prospective college students. Therefore, as a first approximation in assessing the overall intelligence levels of LBs and LOs, we examined SAT scores, which were already on file for students who had participated in our experiments. Total scores on this test were of particular interest; if LOs are more accurate in judging temporal order in the dichotic fusion TOJ experiment simply because they are more intelligent, then they ought to achieve higher overall SAT scores. Performance on the Verbal and Quantitative subtests was also of interest; for example, if LBs performed better on the Verbal test, then it might be more appropriate to think of them as "language-sensitive" rather than "language-bound." Finally, various correlations were examined in order to determine the extent to which each group relied on similar processes to solve different types of problems.

Method

Subjects. Three samples of subjects were studied, drawn from three different editions of the introduction to cognition course at Yale. All subjects met certain *a priori* criteria (they were right-handed, had no history of hearing trouble, and spoke English as their native language), and were classified as LB and LO on the basis of the dichotic fusion TOJ experiment. Sample 1 was composed of 45 subjects: 18 LBs (13 males, 5 females) and 27 LOs (18 males and 9 females). Sample 2 had 53 subjects: 28 LBs (15 males, 13 females) and 25 LOs (12 males, 13 females). Sample 3 had 50 subjects: 22 LBs (16 males, 6 females) and 28 LOs (11 males and 17 females). Thus there were 148 subjects in all: 68 LBs (44 males, 24 females) and 80 LOs (41 males and 39 females). Since SAT scores were not available for all the students, the numbers given here do not represent general LB-LO or male-female proportions in the classes.

The mean ages of subjects in Samples 1-3, respectively, were 19.0, 19.6, and 19.3. There were no differences in age between LBs and LOs in any of the samples, as indicated by an analysis of variance with group, sex, and sample as factors. However the males were older than the females [19.5 versus 19.1, F (1, 136) = 4.54, p<.05], and the samples differed in mean age [F (1, 136) = 3.69, p<.05] with Sample 2 subjects older than those in Sample 1 (by a Newman-Keuls test).

Statistical Approach. To date about 1,000 subjects have been run in various versions of the dichotic fusion TOJ experiment. The data indicate that there are no sex differences in the distribution of LBs and LOs. However, since females generally perform better on verbal tasks and males on quantitative tasks, sex was included as a factor in the analyses conducted here. The text emphasizes the LB-LO distinction; whatever sex effects occurred are mentioned only briefly.

Analyses of variance were conducted separately for each sample (with group, sex, and subtests as factors) and for all subjects combined (with group, sex, subtest, and sample as factors). All reliable main effects and interactions are mentioned in the text; all others can be assumed to be nonreliable. Multiple comparisons were made using the Newman-Keuls procedure and the outcomes mentioned in the text were reliable at the p<.05 level or better.

Various pairs of scores were examined. Many were expected to yield correlations in a particular direction. For example, the correlation between Verbal and Total scores was expected to be positive. For others (especially some examined in later sections of the paper), there was no *a priori* basis for predicting the nature of the relationship. Therefore the more conservative two-tailed assessment of statistical reliability was used for all correlations in order to make comparisons among all of them. All correlations that met the conventional levels of reliability were positive; therefore the term "positive" will not be reiterated each time a reliable correlation is presented.

Performance Measures

Total Score. Mean SAT scores are shown in Table 1. There were no reliable differences between LBs and LOs in Total score in any of the three samples. F-values for the group factor for Samples 1-3, respectively, were F (1, 41) = 0.41, F (1, 49) = 1.54, and F (1, 46) = 2.31, all with p>.10. The analysis of all samples combined also yielded no reliable LB-LO differences [F (1, 136) = 3.76, p>.05]. Given that SAT scores are widely considered to reflect overall intelligence, these results suggest that LBs and LOs do not differ in general intellectual level.

Subtests. Comparison of LB-LO performance on the subtests yielded mixed results across the three samples. In Sample 1, LBs achieved higher Verbal scores than LOs, while LOs achieved higher Quantitative scores than LBs [interaction F (1, 41) = 6.50, p<.01]. The form of this interaction suggested that LBs may be more "language-sensitive" while LOs are more "math-sensitive." However this interpretation should be viewed with considerable reservation for the same results did not occur in the other two samples. These samples did not yield reliable group X subtest interactions and furthermore the relationships among the values composing the potential interaction were very different from those in Sample 1. In the combined analysis over all subjects, there were no reliable differences between LBs and LOs in their subtest performance [interaction F (1, 136) = 0.26, p>.10].

Other Effects. Sex differences occurred only in Sample 1, where males achieved higher overall scores than females [F (1, 41) = 7.96, p<.01]. The male-female difference in this sample varied as a function of subtest [interaction F (1, 41) = 13.45, p<.001] with males reliably higher on the Quantitative test (716 versus 611) but not on the Verbal test (674 versus 661). In the combined analysis, males had reliably higher scores [684 versus 657, F (1, 136) = 5.73, p<.05], and differed from the females on the subtests [interaction F (1, 136) = 8.79, p<.01] by having higher Quantitative scores.

Table 1

Mean SAT Scores for LBs and LOs

	Verbal		Quantitative		Total	
Sample	LB	LO	LB	LO	LB	LO
1	677	658	641	687	1318	1345
2	674	708	691	698	1365	1405
3	619	659	652	672	1272	1335
All subjects:	658	676	668	691	1325	1367

Subjects in the three samples did not achieve comparable overall SAT scores [F (2, 136) = 4.54, p<.05]; Sample 2 subjects had higher scores than those in Sample 3. Sample 2 subjects were also older, as mentioned above, since there was a one-year hiatus in teaching the cognition course between Samples 1 and 2. Thus Sample 2 subjects were primarily juniors and seniors while those in the other samples were primarily sophomores and juniors. Evidently students with lower overall SAT scores are less likely to take scientific psychology courses after declaring a major at the end of their sophomore year.

As expected from the separate analyses of each sample, the combined analysis yielded reliable effects for the interaction of sample with group and subtest [F (2, 136) = 4.34, p<.05] and with sex and subtest [F (2, 136) = 3.71, p<.05]. No other main effects or interactions were reliable in any of the analyses.

Correlations between SAT and TOJ Performance

Another way to assess the extent to which general intelligence might account for the LB-LO differences in the dichotic fusion TOJ experiment is to study the relationship between SAT scores and performance on the TOJ experiment itself. If strong positive correlations exist, they would suggest that the kinds of intellectual abilities tapped by the SAT are also involved in good TOJ performance. Of the eight types of trials in the TOJ experiment (stop or liquid leading by 50, 75, 100, or 125 msec), trials in which the liquid led by 75 msec maximally discriminate between LBs and LOs. This score was used as the measure of TOJ performance in a series of correlations with SAT scores. The results are shown in Table 2. None of the correlations was statistically reliable and the highest was only .21. This means that a maximum of 4% of the variance in TOJ performance is accounted for by the abilities measured by any of the SAT scores. Thus these analyses lend additional support to the view that general intelligence level is not primarily responsible for the observed LB-LO differences in the TOJ experiment.

Table 2

Correlations Between SAT Scores and a Critical Measure of TOJ Performance. (See text for details)

Sample	Verbal	Quantitative	Total
1	-.04	.19	.10
2	.21	.02	.13
3	.20	.08	.17
All subjects	.12	.10	.13

Note: none of these correlations is statistically reliable.

Correlations within the SAT

Correlations among Total, Verbal, and Quantitative scores are shown schematically for the three subject samples in Figure 1. For each sample, it is useful to examine the data for all subjects first, and then determine the extent to which each group varied from this baseline and/or each other. The only comparison where interesting contrasts occurred involved the relationship between the Verbal and Quantitative subtests. A strong positive correlation suggests that the subjects used at least some of the same types of cognitive processes to perform both tasks. Unfortunately, it does not tell us how such a relationship came about. While it is more likely that subjects relied heavily on verbal, rather than quantitative, processes to perform both tests, they may instead have relied on another set of more general processes, such as "reasoning ability." Without further work, we can only say that strong positive correlations indicate some type of "cognitive connectedness." The Verbal-Quantitative relationship in the individual samples yielded mixed results, with LBs showing a reliable relationship in Sample 3, LOs in Sample 1, and both groups in Sample 2. For all samples combined, both groups showed reliable relationships between the two subtests. Therefore LBs and LOs did not show consistent differences in cognitive connectedness, as measured by these correlations.

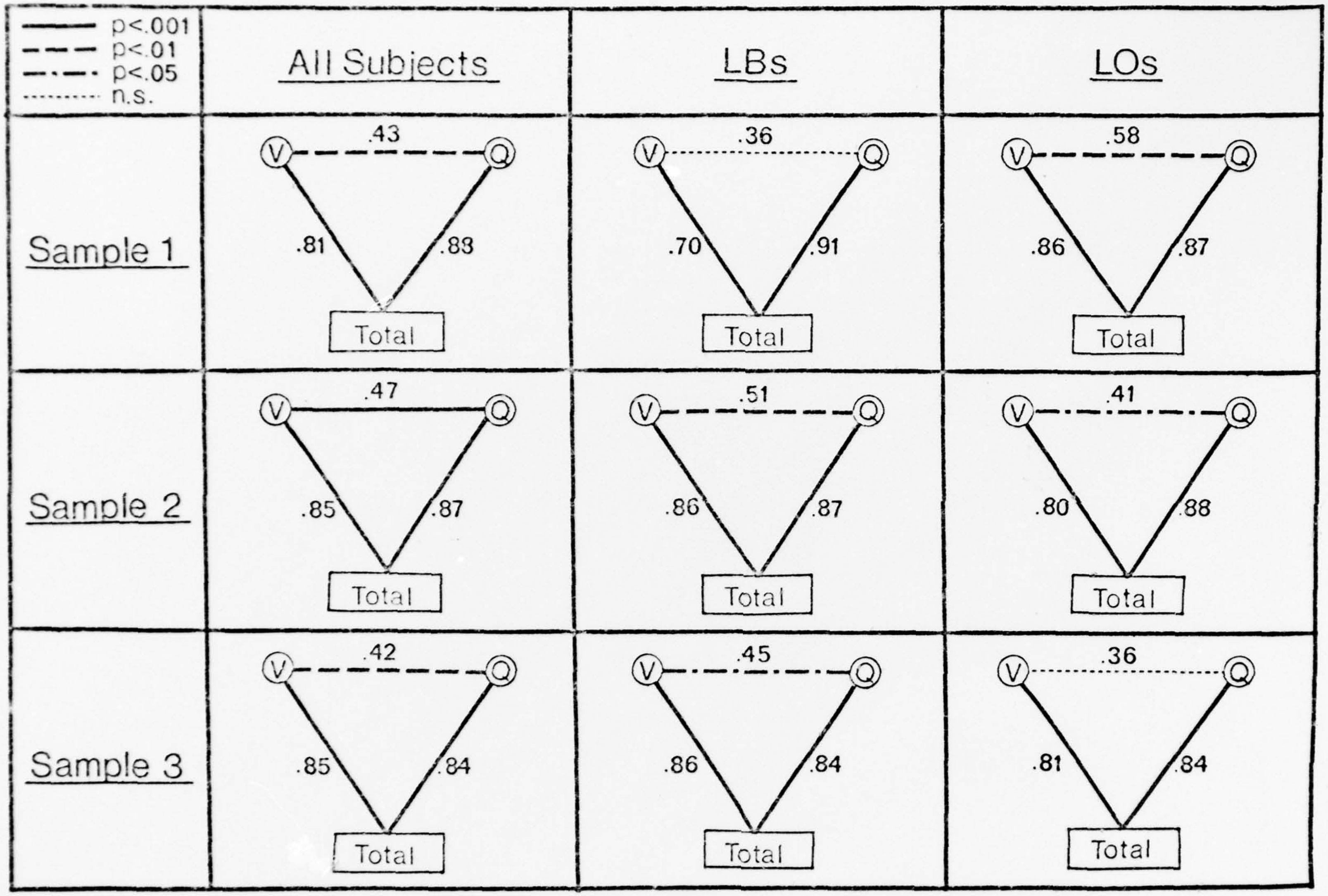

Figure 1 - Correlations among Verbal (V), Quantitative (Q), and Total scores for the SAT.

Primary Mental Abilities

If we want to assess the relative intellectual capabilities of LBs and LOs, it makes sense to use tests explicitly designed to study intelligence. Even if we do not have a strong position concerning the nature of intelligence (e.g., as composed of many specific factors or only one very general factor), it is still useful to know whether the two groups differ in their performance on a standardized intelligence test.

Many intelligence tests are currently available. The Primary Mental Abilities (PMA) test was selected for the present work for several reasons. First, its total score provides an estimate of general intelligence, while its subscales are designed to reflect "primary factors" of intelligence rather than highly task-specific abilities. Second, it is relatively quick and easy to administer, which was important in terms of integrating this inquiry into an intensive series of experimental sessions with the same set of subjects. Finally, the PMA subscales are of particular interest. The Verbal Meaning and Number Facility subscales should reflect the same sorts of skills needed for the Verbal and Quantitative subtests of the SAT, and hence enable us to make fairly direct comparisons between the two tests. The Spatial Relations subscale is also of interest, since previous studies suggested that LBs and LOs differ in this type of mental activity (e.g., Day, 1978). The Reasoning subscale is a potentially useful addition to our empirical knowledge concerning the two groups since it is designed to reflect general and complex aspects of cognitive functioning.

Method

Subjects. All subjects from Sample 2 took the PMA test, except for one LO male who dropped out of school. Three other students (one LO male and two LO females) from the same class also participated; they were not included in the SAT analyses because their scores were not available from the college registrar's

office. Thus there were 55 subjects in all, 15 LB males, 13 LB females, 12 LO males, and 15 LO females.

Statistical Approach. Statistical evaluations followed the same general approach as described for the SAT data. Other procedures needed specifically for the PMA are described below.

Performance Measures

Total Score: IQ. The total raw score achieved by each subject was converted to an overall intelligence quotient (IQ) using the table provided in the PMA manual. LBs and LOs did not differ reliably in IQ. Their scores were 139 and 143, respectively [F $(1, 51) = 2.94$, $p > .05$].

Subscales. Raw scores from the four subscales were also converted into IQs using their respective PMA tables. The data were then evaluated in another analysis of variance with group, sex, and subscale as factors. This analysis weighted each subscale equally, whereas the total IQ measure reported above was based on differential weightings.[1] Therefore the overall means in this analysis cannot be interpreted as "IQ" scores in the usual way. Nevertheless LBs and LOs did not differ reliably in overall scores in this analysis either [130 versus 132, F $(1, 51) = 2.09$, $p > .10$]. Furthermore there was no difference between the two groups on any of the subscales [interaction F $(3, 153) = 0.56$, $p > .10$].

Other Effects. There was no reliable difference between males and females in overall IQ [143 versus 138, F $(1, 51) = 3.23$, $p > .05$]. However males did achieve reliably higher overall scores in the unweighted subscale analysis [133 versus 129, F $(1, 51) = 6.15$, $p < .05$]. There were sex differences among the subscales [interaction F $(3, 153) = 6.77$, $p < .05$]; males achieved higher scores than

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[1] The differential contribution to the total PMA raw score is based on the number of items contained in each subscale as well as the scoring conventions required by each. The proportion of total possible points contributed by each subscale is .26 for Verbal, .13 for Number, .30 for Reasoning, and .30 for Spatial.

females on the Number (140 versus 133) and Spatial (125 versus 114) subscales, but there was no reliable difference on the Verbal (133 versus 135) and Reasoning (134 versus 133) subscales.

The subscales proved to be differentially difficult [$\underline{F}$ (3, 153) = 51.01, $\underline{p}$<.01]. Subjects scored lower on the Spatial subscale (120) than on the Verbal (134), Number (136), and Reasoning (134) subscales.

Enjoyment Ratings

Informal observations in other experiments suggested that LBs and LOs differ in the extent to which they enjoy performing various types of cognitive operations. Spatial tasks were especially interesting in this regard. LOs often spontaneously commented that they enjoyed the box-folding task of the Space Relations Test (from the Differential Aptitude Test battery), while LBs grumbled quite audibly about it. In order to study task enjoyment in a more formal way, subjects were asked to rate their liking for the PMA tasks at the end of the testing session. They used a 7-point scale, where 7 indicated that they 'liked it very much,' while 1 indicated that they 'disliked it very much.' Since the Reasoning subscale is based on three subtests, the mean of these three ratings was used to represent it.

There were no main effects of group, sex, or subscale in an analysis of variance of the enjoyment ratings. However there was an interesting interaction between groups and subscales [interaction $\underline{F}$ (3, 153) = 3.42, $\underline{p}$<.05]. In a subsequent Newman-Keuls test, none of the LB-LO comparisons reached the conventional level of reliability. LB-LO ratings, fespectively, were 4.6 and 4.6 for Verbal, 4.7 and 4.2 for Number, 4.4 and 4.3 for Reasoning, and 3.7 and 4.8 for Spatial. Since the Spatial subscale yielded the largest numerical difference and since it was of special interest on a priori grounds, it was analyzed separately. Evidently LBs did not like the task as well as LOs [$\underline{F}$ (1, 51) = 5.25, $\underline{p}$<.05].

Although the evidence is clearly marginal from a statistical standpoint, it is still of interest. It raises the possibility that LBs may have liked the Spatial task less because it was more difficult for them and hence they had to "work harder" than LOs to achieve comparable performance scores. This possibility is consonant with the fact that in previous work with other subjects, LBs performed more poorly than LOs on the more difficult Space Relations Test (Differential Aptitude Test).

There was also an interaction of sex and subscale in the enjoyment ratings [$\underline{F}$ (3, 153) = 3.04, $\underline{p}$<.05], although none of the male-female comparisons was statistically reliable in a subsequent Newman-Keuls test.

Correlations between PMA and TOJ Performance

In order to determine the extent to which PMA performance and the TOJ experiment reflect similar cognitive operations, correlations between the two sets of scores were conducted. The PMA measures used were IQs while the TOJ measure was again percent correct for trials where the liquid led by 75 msec. Correlation values were .12 for the Verbal subscale, .08 for Number, .24 for Reasoning, .18 for Spatial, and .22 for Total scores. None of these relationships was statistically reliable. Only a maximum of 6% of the variance in TOJ performance can be accounted for by the processes reflected by any of the PMA scores. Again, the argument that intelligence differences are responsible for the contrast in LB and LO performance in the TOJ experiment is less tenable given these results.

Correlations within PMA

Total versus Subscales. The various subscales of the PMA were highly correlated with Total PMA score for all subjects, as shown in Figure 2. The same general pattern of correlations was produced by LBs and LOs, which demonstrates simply that the subscales contributed to total scores in a similar fashion for the two groups.

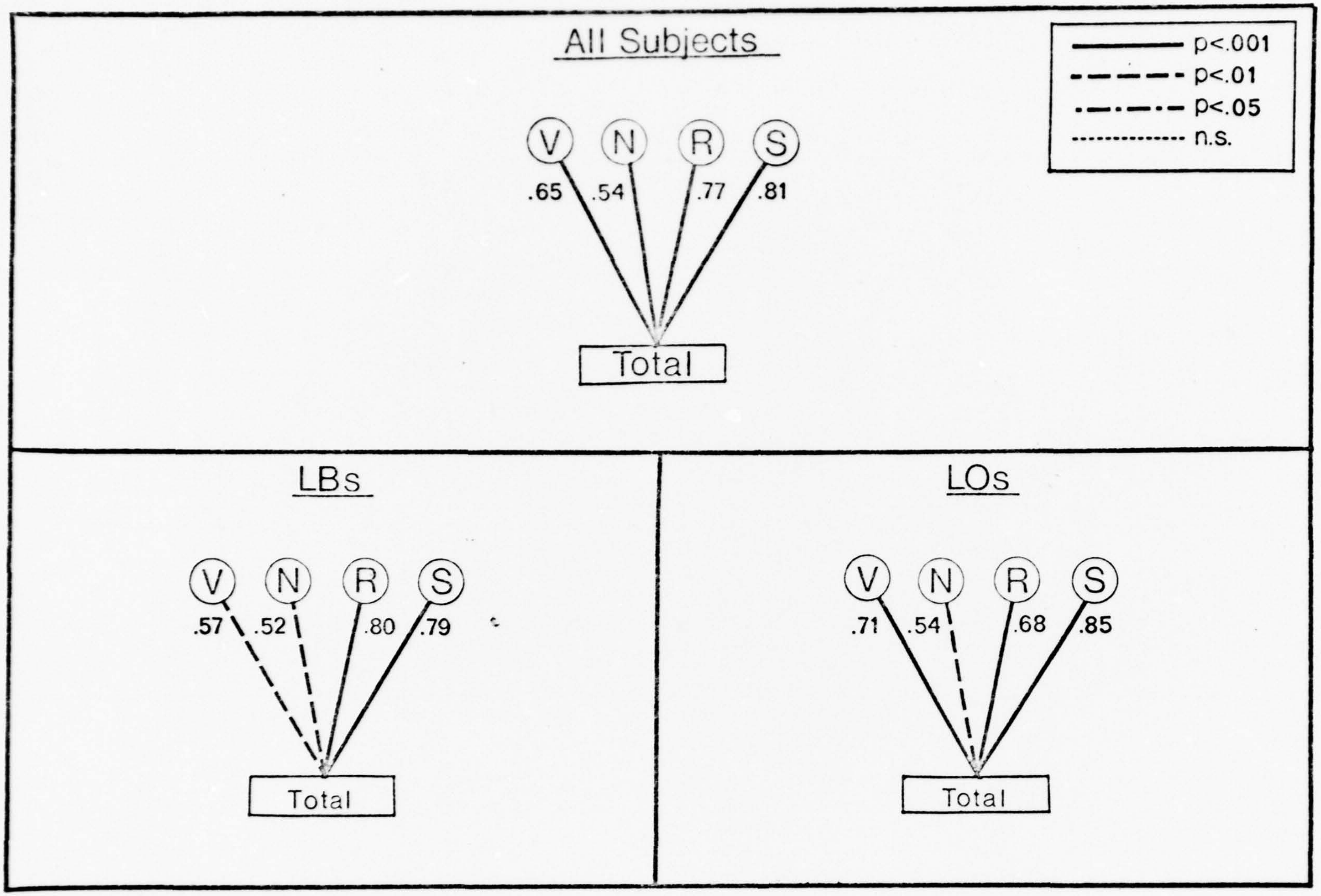


Figure 2 - Correlations between each subscale of the PMA and Total PMA score. V = Verbal Meaning, N = Number Facility, R = Reasoning, S = Spatial Relations.

Among Subscales. The pattern of intercorrelations of subscales was more interesting, as shown in Figure 3. All pairs of subtests except Verbal-Number were reliably correlated for the combined pool of subjects. However, LBs showed more interconnections among the subtests than LOs; they had three reliable connections while LOs had only two. It is difficult to interpret the basis of these correlations in a very specific way. If a given subscale has more than one reliable connection with the others, then it might be considered to be "pivotal;" that is, the processes particular to it might be used for the other types of tasks as well. If so, then Reasoning processes were strongly pivotal for LBs since this subscale was linked with all the others. For LOs the potentially pivotal Verbal subscale was linked with only two of the other subscales.

This general type of interpretation is of course limited by the fact that correlations do not indicate causality or directionality. Another type of problem is that some of the PMA subscales are quite constrained in the range of items they include. Most notable is the Verbal subscale which includes only synonym problems. By contrast, the Verbal subtest of the SAT generally includes such problems as antonyms, analogies, sentence completions, and comprehension. Thus the PMA Verbal subscale is a less comprehensive test of general verbal ability and hence its ability to produce intercorrelations with the other subscales may well be limited.

Given the various problems in interpreting the intercorrelations among subtests, the contrasting patterns produced by LBs and LOs are still interesting. The two groups agreed on the presence of only one link, namely that between the Verbal and Reasoning subscales, and in the absence of links between Verbal-Number and Number-Spatial. Concerning the remaining links which each group had, it is probably best to conclude simply that LBs showed more connectedness.

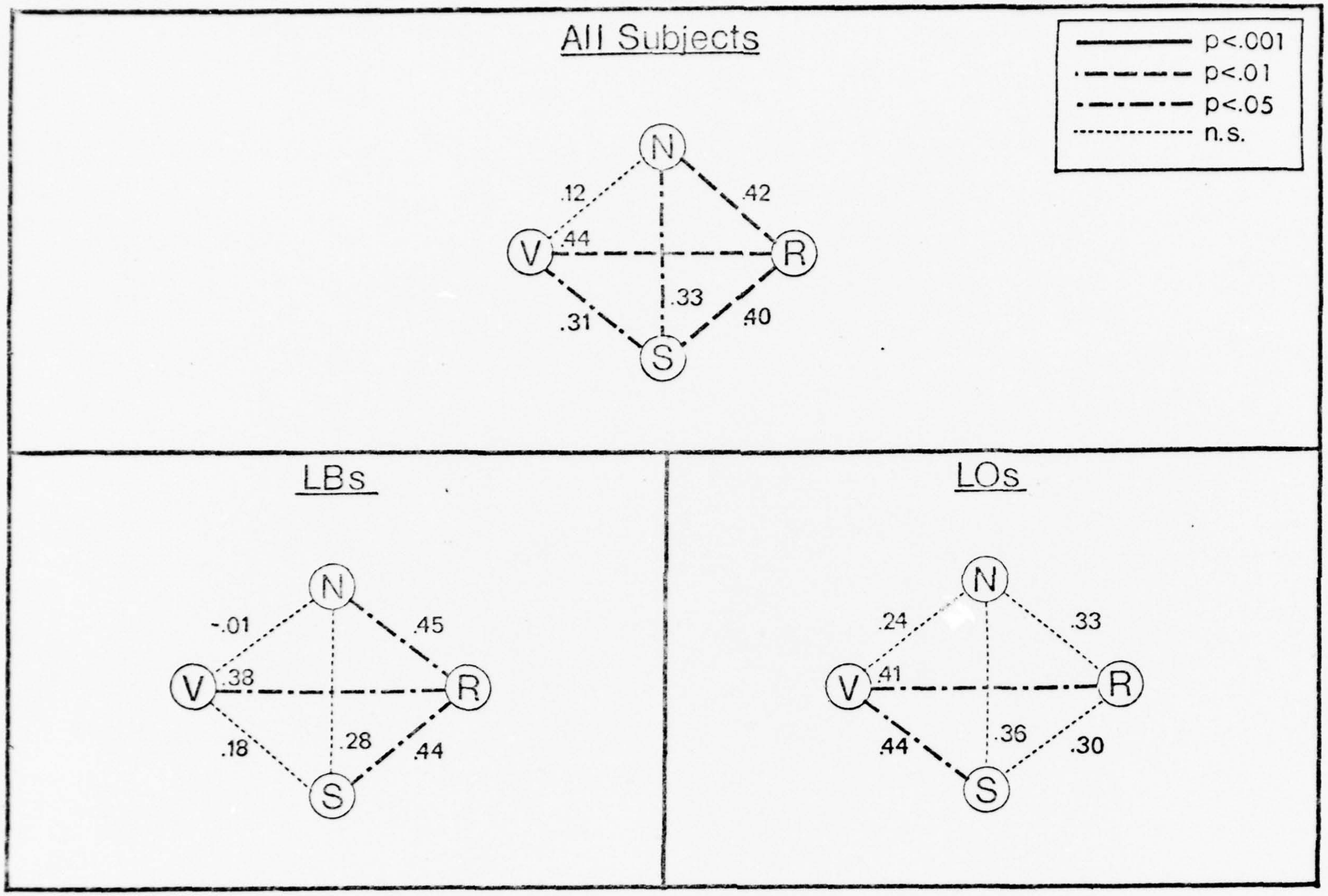


Figure 3 - Correlations among Verbal Meaning (V), Number Facility (N), Reasoning (R), and Spatial Relations (S) subscales of the PMA.

Comparison of SAT and PMA

Total Score for Both Tests

Evidently the two tests measured similar sets of mental operations, since their total scores were positively related over all subjects, as shown in Figure 4. This relationship was reliable for LBs, but not for LOs. Although the contrasting correlation values were admittedly close, they nevertheless represent another case in which LBs showed more cognitive connectedness than LOs.

Total versus Subtests

Of the six relationships between total score on one test and subtest scores on the other, four were statistically reliable over all subjects, also shown in Figure 4. LBs again had more reliable links; they had three links while LOs had only one. Both groups had a link between SAT Total and PMA Number. In addition, LBs had a link between SAT Total and PMA Reasoning, which is interesting since Reasoning was "pivotal" for them in the correlations among the PMA subtests. LBs also had a link between PMA Total and SAT Quantitative. If linkages reflect reliance on common sets of mental operations, then LBs showed more overlap between the tests in the operations they used. LOs evidently relied on a greater variety of operations to perform the various tasks.

The lack of a reliable link between SAT Total and PMA Verbal for both groups and for all subjects combined is noteworthy. It is consonant with the fact that the PMA Verbal is not a very comprehensive test of verbal ability, as described above.

Among Subtests. The relationships among the SAT and PMA subtests are shown in Figure 5. For all subjects, the PMA Number and Reasoning were both linked to the SAT Verbal and Quantitative. Of these four links, LBs had two and LOs had one.

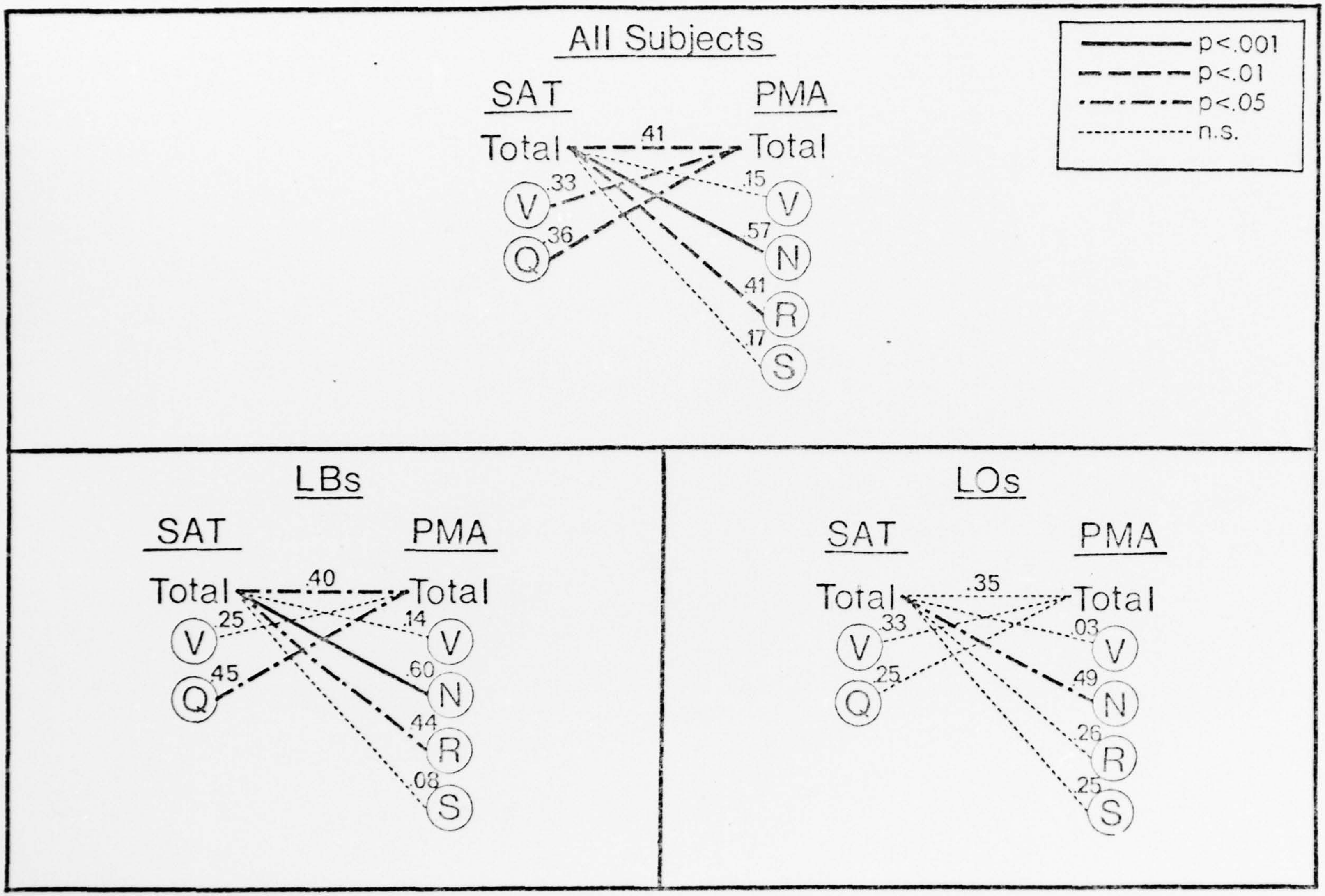


Figure 4 - Correlations between total score on one test with subtest scores on the other. For SAT, V = Verbal, Q = Quantitative. For PMA, V = Verbal Meaning, N = Number Facility, R = Reasoning, S = Spatial Relations.

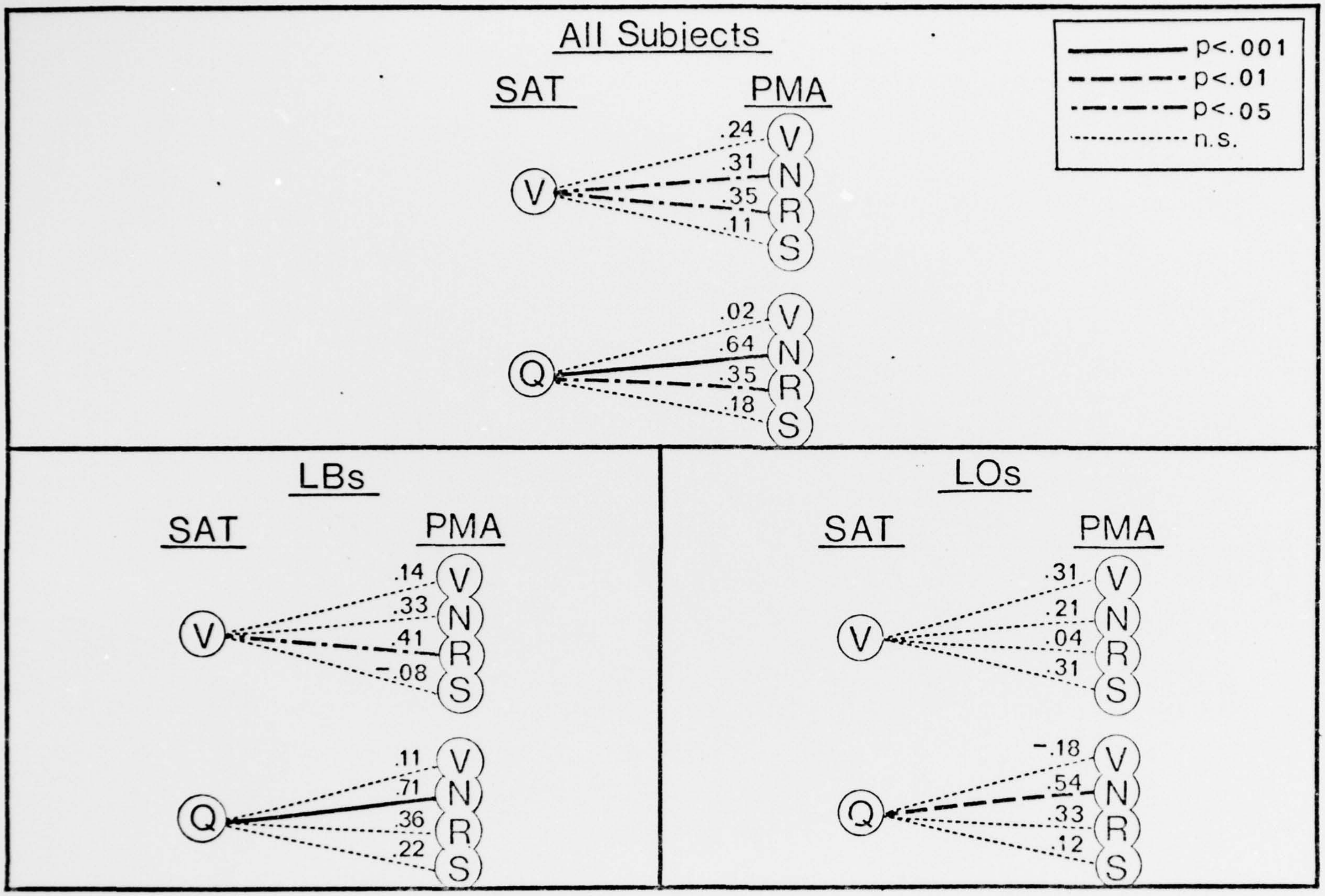


Figure 5 - Correlations between SAT subtests and PMA subtests. For SAT, V = Verbal, Q = Quantitative. For PMA, V = Verbal Meaning, N = Number Facility, R = Reasoning, S = Spatial Relations.

Both groups had links between SAT Verbal and PMA Number. LBs also had one between SAT Verbal and PMA Reasoning, which again emphasizes the importance of reasoning processes in these individuals,

Since both the SAT and PMA have "Verbal" subtests, it seems reasonable to expect a strong positive correlation between them. However they were not reliably related, either for LBs, LOs, or all subjects combined. Evidently there was not much overlap in the processes that subjects used for these two subtests. Alternatively, the lack of correlation might be based on different testing approaches of the SAT and PMA, or in students' motivation in taking them. However, since there were strong links between the two tests for their math-based subtests (SAT Quantitative and PMA Number), this interpretation does not seem very likely. Instead it appears that the narrow scope of the PMA Verbal, relative to the more comprehensive scope of the SAT Verbal, reduced the opportunity for the same processes to be employed for both subtests. Therefore the interpretation of linkages between the PMA Verbal and other PMA subtests should be made in fairly task-specific terms, rather than more general terms.

Overview

Overall Intelligence

The differences between LBs and LOs in various perception and memory experiments do not appear to be based on differences in overall intelligence level. The two groups achieved comparable overall scores both on the SAT (replicated for three samples of subjects) and on the PMA. Furthermore these scores were not correlated with a critical measure of TOJ performance.

The overall level of scores on both tests was high. Therefore it might be argued that the tests were too easy and hence ceiling effects prevented us from detecting whatever intelligence differences might exist between LBs and LOs. If this were the case, then other partitionings of the subjects (for example, by sex) should also yield negligible differences. However, males achieved both higher SAT scores and higher PMA scores (unweighted analysis). Therefore ceiling effects cannot be wholly responsible for the lack of differences between LBs and LOs on these tests.

Subtest Comparisons

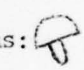
LBs and LOs could achieve comparable overall scores on a given test yet differ markedly in their performance on the component subtests. Since LBs achieved superior SAT Verbal scores while LOs achieved superior SAT Quantitative scores in one sample of subjects, it is tempting to view LBs as "language-sensitive" and LOs as "math-sensitive." However this interpretation does not have much generality, given the absence of similar findings in the other two samples. Furthermore the two groups did not differ in their Verbal and Number scores on the PMA, nor in the other two PMA subscales. Thus the present data are most notable for their lack of differences between LBs and LOs on the various subtests.

The argument that ceiling effects obscured true differences between LBs and LOs in their subtest performance is not convincing. Since there were reliable differences both among SAT subtests and PMA subtests for another partitioning of

the subjects (males versus females), there was ample statistical opportunity for LB-LO differences to occur.

The subtests of the SAT are fairly comprehensive, while those of the PMA are somewhat more specific in nature. Despite the fairly wide range of cognitive operations required by all of these subtests together, LBs and LOs could still differ in their ability to perform other types of operations and/or different combinations of operations. Therefore it might be useful to study other intelligence tests that sample a wider range of more specific abilities.

Alternative Ways to be Intelligent

The lack of LB-LO differences in total and subtest socres suggests that the two groups have comparable levels of intellectual ability, at least as reflected by the SAT and PMA. However these results do not necessarily imply that they performed the various tasks in the same ways. There are alternative ways to solve many of the problems on these tests. For example, when given a figure such as:  on the PMA Spatial Relations subtest, LBs might code it as "leftward-leaning mushroom, with stem on left" and then search for matching figures on the basis of this linguistic code, while LOs might rely more heavily on a visual image to make the match. Without additional experiments designed to study these subtests in a more analytical way, we cannot determine whether LBs and LOs used different forms of information processing in each task.

Other aspects of the data suggest that the two groups may have differed in the number of cognitive operations they used. Correlations among all SAT and PMA scores suggest that LBs may have more "cognitive connectedness." Since LBs had more reliable links among their test scores, they may have relied more heavily on a common set of cognitive operations to perform the various tasks, whereas LOs used a wider variety of more specialized operations. LBs had all of the same links as

LOs, except for the one between the Spatial and Verbal subtests of the PMA. In addition, they had six links not present for LOs. Of these, four involved the Reasoning subscale of the PMA. Thus the abilities measured by this subtest were apparently very important for LBs, and may well play a pivotal role in their general cognitive functioning.

Conclusion

It is often difficult to accept the null hypothesis, in this case, that LBs and LOs do not differ in overall intelligence. One could always argue that the tests were not sensitive enough or that more subjects are needed to observe "true" differences. The present study is admittedly a preliminary one. It has examined only two tests. Furthermore these tests were given and scored exactly according to standardized procedures. It might be useful to examine more difficult tests and/or cut back on the time allowed for each in order to reduce performance levels. Such modifications might increase our chances of observing differences between the two groups.

Despite such suggestions for future work, the present study presents quite convincing evidence about the primary question it examined: LBs and LOs did not show gross differences in overall intelligence. This finding occurred first for the SAT which is not noted for its easiness, and was replicated three times for samples of about 50 subjects each, as well as for the combined pool of 148 subjects. It also occurred for a standard test of intelligence (the PMA). If there were "true" gross differences between LBs and LOs, they should have shown up under these circumstances.

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